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Indian Standard

SPECIFICATION FOR SILICONE COMPOUNDS FOR APPLICATION ON HIGH VOLTAGE PORCELAIN INSULATORS

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SPECIFICATION FOR SILICONE COMPOUNDS FOR APPLICATION ON HIGH VOLTAGE PORCELAIN INSULATORS

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Indian Standard

SPECIFICATION FOR SILICONE COMPOUNDS FOR APPLICATION ON HIGH VOLTAGE PORCELAIN INSULATORS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 18 April 1975, after the draft finalized by the Electrical Insulators and Accessories Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This specification deals with silicone compounds suitable for application either by hand or by brush or by sprayer on the surface of high voltage porcelain or glass insulators to prevent by their hydrophobic action the flashover of insulators due to pollution of the insulator surface by dusts, salts, fumes, coal dusts, cement dusts, and chemical precipitates from atmosphere.

0.3 There are various types of silicone compounds, all of which are not suitable as an electrical insulating material for the purpose of prevention of flashover due to pollution. Silicone oil is also not suitable for this purpose. It shall, however, be ensured that the application of the silicone compounds shall not lower the electrical characteristics of the insulators.

0.4 The hydrocarbon based compounds are also employed for the purpose of prevention of pollution on insulators.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the composition, classification and requirements of silicone compounds suitable for application on the surface of high voltage porcelain insulators to prevent by their hydrophobic and encapsulating action the flashover of insulators due to atmospheric pollution.

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*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Softening Point — The temperature at which a substance attains a particular degree of softness under specified conditions of test.

2.2 Arc Resistance — The numerical value of the time in seconds from the start of the test until failure by the formation of a continuous bright line between the electrodes shall be recorded as the measure of the arc resistance of the compound.

3. COMPOSITION

3.1 Silicone compounds or pastes are compounds of an organo-polysiloxane oil with a reasonably flat viscosity-temperature curve and incorporating thickners such as graphite, aerosil, inorganic soaps or molybdenum sulphide. The properties of these thickners determine the nature of the silicone compound and consequently the possible uses. All thickners are not suitable for the purpose of prevention of atmospheric pollution. The materials should be homogeneous, smooth in texture and free from lumps and dirts.

4. CLASSIFICATION

4.1 Silicone compounds for application on high voltage insulators are divided into the following two types:

Type A — In paste or compound form ready to be applied on the cleaned dry insulator by hand or brush.

Type B — In liquid form, to be applied on the cleaned dry insulator by suitable methods such as spraying or dipping.

5. REQUIREMENTS

5.1 Silicone compounds for application on high voltage insulators shall comply with all the requirements covered in **5.2** and **5.3** for type A and type B respectively.

5.2 Type A Silicone Compound

5.2.1 *General* — It shall be translucent, vaselinelike consistency, with very high resistance to heat and oxidation and very small change in consistency over a wide temperature range. It shall be chemically inert and physiologically inert (nontoxic), and shall not attack insulators and their associated metal fittings. The nontoxicity shall be certified by a recognised testing institution. It shall have the following other characteristics:

a) *Physical characteristics*

1) Colour — In its natural form, the colour should be translucent white, light grey or cream.

   NOTE — A dye or pigment of any colour except black may be added, if required by the user, provided the finished compound meets the other requirements of this specification.

2) Odour — The silicone compound shall be odourless.

3) Specific Gravity — The specific gravity shall be approximately 1·0 when measured at 27°C.

4) Service Temperature — There shall be almost no change in the viscosity of the compound in the temperature range of minus 50°C to plus 200°C.

5) Unworked Penetration — The silicone compound shall have the penetration characteristics as follows:

   Unworked penetration = Minimum 200
   Maximum 260

   Worked penetration = Maximum 300

6) Bleed or Oil Separation — The silicone compound shall not have the bleed or oil separation more than 10 percent.

7) Volatility or Weight Loss on Heating — This loss of silicone compound shall not exceed 3 percent.

8) Solvent — The silicone compound shall be relatively insoluble. When the compound is immersed in the following solvents, the allowable loss in weight for the compound in each solvent shall not exceed as given below:

Solvent	*Maximum Percent Loss by Weight*
Distilled water	0·4
Isopropyl alcohol (91 percent)	10·0
Ethyl alcohol	7·0
Ethylene glycol	0·5
Glycerine	0·5

9) Solidifying Point — The silicone compound shall have the solidifying point not exceeding −60°C.

10) Softening Point — The compound shall remain unsoftened at temperature of 200°C when tested in accordance with IS : 1205-1958*.

11) Acid Value — The acid value of the silicone compound shall be 0·3.

b) *Electrical characteristics*

1) Electric Strength — The silicone compound shall have the minimum electric strength of 10 kV/mm.

2) Volume Resistivity — The silicone compound shall have the following values of the volume resistivity:

at 27°C — about 10^{14} ohm. cm, and

at 150°C — about $1·3 \times 10^{12}$ ohm.cm.

3) Surface Resistivity — The silicone compound shall have the minimum surface resistivity of 10^{14} ohm.cm.

4) The silicone compound shall have the dielectric loss (tangent δ) at room temperature (dry) at different frequencies as follows:

Frequency	*Value of the Tangent* δ
50 Hz	about 0·000 1
0·1 MHz	about 0·000 9
1 MHz	about 0·001

5) The silicone compound shall have the dielectric constant approximately equal to 3 at room temperature (dry)

6) Arc Resistance — The arc resistance of the silicone compound shall be 80 seconds or more.

c) *Resistance to chemicals* — Fully resistant to water, water vapour, melhanol, elharol, glycerine, mineral oils, animal oils, vegetable oils, 25 percent caustic soda, 10 percent sulphuric acid, hydrochloric acid (1 : 15), 10 percent nitric acid, cooking salt solution.

Moderately resistant to acetone, 40 percent cold caustic soda, 30 percent cold caustic potash.

Not resistant to concentrated sulphuric acid and nitric acid, toluol, xylol, white spirit, ethyl acetate, carbon tetrachloride, butanol.

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*Determination of softening point.

5.3 Type B Silicone Compound

5.3.1 The characteristics of the silicone compound in the solution shall be as given in **5.2**.

5.3.2 Solvent component should not be more than 80 percent. The manufacturers shall declare the percentage contents of silicone compound in the solution.

5.3.3 The solvent shall not have deleterious effect on the insulator fittings, galvanised components, spray guns and spray hot-sticks.

5.3.4 It should be kept in mind that if the specific weight of the solution is high, it cannot be sprayed easily with ordinarily available hand spray guns.

6. TEST METHODS

6.1 Method for the Determination of Penetration — The penetration of the compound, worked and unworked, shall be determined in accordance with IS : 1448 [P : 60]-1971*.

6.2 Method for the Determination of Volatility or Heating Weight Loss and Bleed or Oil Separation

6.2.1 *Apparatus* — The following apparatus shall be required:

a) Wire gauge filter cone, 40 mm diameter and 40 mm slant height, made from nickel gauge of No. 60 mesh in accordance with IS : 460-1962†.

b) Beaker 200 ml (tall form) approximately 100 mm high and having 65 mm diameter.

c) Oven, ventilated (by convection).

6.2.2 *Procedure* — Suspend the cone from a rod supported on the rim of the beaker, which shall be without a lid. Maintain the temperature of the oven at 200 ± 5°C for 24 hours.

NOTE — The rod will need to be tared with the beaker. The cone shall be hard soldered or welded at the joint in order to withstand the high temperature.

Weigh the entire assembly and calculate the percentage evaporation as follows:

$$\text{Evaporation loss} = \frac{\text{Loss in weight of assembly}}{\text{Weight of sample}} \times 100 \text{ percent}$$

Lift the cone from the beaker and gently tap it against the inside edge of the beaker, to remove any fluid adhering to the tip of the cone. Weigh

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*Methods of test for petroleum and its products: P : 60 Consistency of lubricating greases by cone penetrometer (*first revision*).

†Specification for test sieves (*revised*).

the beaker containing the separated fluid and calculate the percentage of the oil separation as follows:

$$\text{Oil separation} = \frac{\text{Gain in weight of beaker}}{\text{Weight of sample}} \times 100 \text{ percent}$$

6.3 Method for the Determination of Insolubility — About 3 g of the compound, accurately weighed, shall be smeared around the inside of a weighed glass beaker of 250 ml capacity. Approximately 100 ml of the solution are enough to immerse the compound and shall be poured into the container. The container shall be tightly capped with metal foil and left to stand for a period of 7 days at a temperature between 22°C and 28°C. At intervals of approximately 24 hours, the solution shall be stirred by moderate manual rotation of the container. At the end of the 7-day period, the solution shall be poured off, and the container and compound rinsed carefully with successive washes of distilled water until all solvent has been removed. The container and compound shall be dried for 20 hours in an oven at 70°C followed by desiccation for 4 hours over calcium chloride. A blank shall be run to determine the loss due to evaporation which occurs during the treatment. A final weight less than the original weight of the container and compound shall indicate removal of soluble constituents.

6.4 Method for the Determination of Solidifying Point — Maintain the material at a temperature of −60°C for a period of 24 hours. At the end of this period examine the material for any signs of solidification or cracking. At −60°C the material shall not solidify or crack. A slight increase in stiffness of the compound may be disregarded.

6.5 Test Method for Softening Point — The method described in IS : 1205-1958* shall be used. The temperature of the compound shall be 200°C for the determination of the softening point.

6.6 Method for the Determination of the Acid Value — The test procedure shall be same as given in IS : 1448 [P : 2]-1967†.

6.7 Method for the Determination of Electric Strength — Place the compound in a porcelain container fitted with 12·7 mm diameter steel or brass electrodes set 1·25 mm apart, similar to that described in IS : 7084-1973‡. Subject the container and its contents to a slow reduction in air pressure (taking 10 minutes to reduce to 10 mmHg) to cause minimum movement of compound. Continue the pressure reduction to less than 1·0 mm of mercury and maintain at this pressure for one hour or until all traces of air bubbles have been removed. Slowly restore to atmospheric pressure and then maintain the container and its contents at a temperature of 27°C for 3 hours. Then immediately carry out the electric strength test at 27°C.

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*Determination of softening point.

†Methods of test for petroleum and its products: P : 2 Acidity (*first revision*).

‡Specification for bitumen based filling compounds for electrical purposes.

For test voltage source and other details, reference may be made to **B-2.5** to **B-2.9** of IS : 7084-1973*.

The voltage applied to the spherical electrode is raised gradually from zero to 12·5 kV rms in 10 to 15 seconds and maintain at this value for one minute.

Test two samples of the material. If one sample fails to withstand the specified proof voltage for one minute, test a third sample. If this sample fails, the whole lot may be rejected.

6.8 Method for the Determination of Volume Resistivity — Test two specimens of material at room temperature and two specimens at 150°C.

Use a guarded electrode system corresponding to that shown in Fig. 1 in a suitable cell that shall allow precise and accurately measurable separation of the unguarded with respect to the guarded electrode within limits of 0·5 mm and 3 mm.

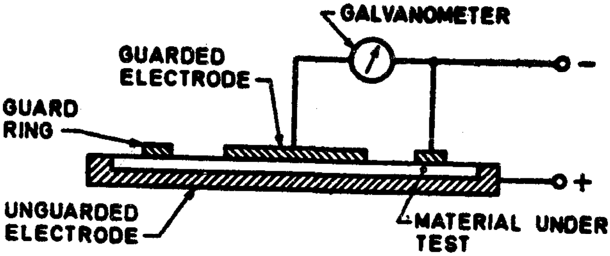

FIG. 1 TYPICAL ARRANGEMENT FOR DETERMINATION OF VOLUME RESISTIVITY

For tests at room temperature maintain the electrodes, test cell, and material to be tested, at 27°C for not less than 24 hours. Spread a layer of the material over the lower (unguarded) electrode to a depth somewhat thicker than the desired test thickness, taking care to avoid trapping air bubbles. Bring the unguarded electrode towards the upper electrode until the material is in contact with the guarded electrode and guard ring and adjust the electrode gap to the desired figure, allowing the material to spread over the whole electrode surface, and again taking care to prevent trapping of air.

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*Specification for bitumen based filling compounds for electrical purposes.

Measure the electrical resistance between unguarded and guarded electrodes after energisation for one minute at a potential of 500 ± 50 volts dc.

$$\text{Volume resistivity} = \frac{A}{S} \times R \text{ ohm.cm}$$

where

A = area in cm^2 of the guarded electrode,

S = thickness in cm of the material, and

R = measured resistance in ohms.

For tests at elevated temperature, spread the layer of material over the lower electrodes at room temperature and then maintain electrodes, test cell, and material at 150 ± 2°C for not less than 4 hours before finally adjusting the distance between the unguarded and guarded electrodes. Measure resistance at 150 ± 2°C and calculate the resistivity as described above.

The volume resistivity shall be recorded as the arithmetic mean of the volume resistivity of the two specimens tested, at each temperature.

6.9 Method for Determination of Surface Resistivity – The procedure for test at 27°C shall be the same as described in **6.8**, but the electric test circuit shall be as described in IS : 3396-1965*.

6.10 Method for the Determination of Dielectric Loss Tangent and Dielectric Constant — Two specimens of the material shall be tested in accordance with IS : 4486-1967† for these requirements.

6.11 Arc Resistance Test Method — The arc resistance shall be determined in air at 27°C using a 3·0 mm layer of the compound spread on a layer of thermal glass, such as quarts or pyrex. The electrodes, the electrode holders, the supply to the electrodes and the circuit arrangement shall be same as given in IS : 2824-1964‡ except that gap between the electrodes shall be 8·0 ± 0·1 mm. Both the electrodes shall be in the same horizontal and vertical planes. The arc electrodes shall be cleaned with a soft clean cloth dampened with alcohol, then dried with a soft, clean dry cloth before each determination.

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*Methods of test for volume and surface resistivities of electrical insulating materials.

†Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths.

‡Method for determination of the comparative tracking index of solid insulating materials.

7. PACKING

7.1 Silicone compound shall be packed in air-tight, clean and dry containers.

8. MARKING

8.1 Each container shall carry the following information:

a) Name or trade-mark of the manufacturer,
b) Type,
c) Year of manufacture, and
d) Quantity.

8.1.1 The containers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

9. SAMPLING

9.1 The recommended sampling scheme is given in Appendix A.

APPENDIX A

(*Clause* 9.1)

SAMPLING FOR THE SILICONE COMPOUNDS

A-1. GENERAL REQUIREMENTS OF SAMPLING

A-1.1 Adequate precautions shall be taken to avoid contamination while drawing and transferring samples to suitable, clean, dry and air-tight glass containers.

A-1.2 Each sample container after filling shall be sealed air-tight and marked with full identification particulars, such as sample number, the date of sampling, the batch of manufacture of material, and other important particulars of the consignment.

A-2. SCALE OF SAMPLING

A-2.1 Lot — In a single consignment, all the containers of the same type, size, and drawn from the same batch of manufacture shall constitute a lot. If a consignment is declared or known to consist of different batches of manufacture or of different sizes of containers or of different types of material then the containers belonging to the same batch under the same size and type shall be grouped together and each such group shall constitute a separate lot.

A-2.1.1 Samples shall be tested for each lot for ascertaining the conformity of the material to the requirements of the specification.

A-2.2 The number of containers (*n*) to be selected from a lot shall depend on the size of the lot (*N*) and shall be as given in Table 1.

TABLE 1 NUMBER OF CONTAINERS TO BE SELECTED FOR SAMPLING

Lot Size *N*	Number of Containers to be Selected *n*
(1)	(2)
Up to 20	3
21 to 40	4
41 ,, 80	5
81 ,, 120	6
121 ,, 200	8
201 and above	10

NOTE — In the case of very small lots where the selection of three containers may be uneconomical, the number of containers to be selected and the criterion for judging the conformity of the lot to the specification shall be as agreed to between the purchaser and the supplier.

A-2.3 The containers shall be selected at random and in order to ensure the randomness of selection, a random number table shall be used. In case such a table is not available, the following procedure may be adopted:

> Starting from one container; count them in one order as 1, 2, 3, ..., up to *r* and so on, where *r* is the integral part of N/n (*N* being the lot size and *n* the number of containers to be selected). Every *r*th container thus counted shall be withdrawn to give samples for test.

A-3. PREPARATION OF TEST SAMPLES AND REFERENCE SAMPLE

A-3.1 To ensure that the sample taken from each container is representative of the contents, the contents shall be mixed thoroughly by shaking or by stirring or both.

A-3.2 After the contents are thoroughly mixed, a small representative portion of the material shall be taken with the help of a suitable sampling instrument from each of the containers selected. The total quantity of the material drawn from each container shall be sufficient to conduct tests for all requirements as specified in this standard.

A-3.3 The material taken from each container shall be divided into three equal parts, each forming an individual sample. One set of the individual samples representing *n* containers selected shall be marked for the purchaser, another for the supplier and the third to be used as a reference sample.

A-3.4 All the samples shall be transferred to separate containers. These containers shall then be sealed air-tight and labelled with full identification particulars as given in **A-1.2**.

A-3.5 The reference sample consisting of a set of *n* individual samples representing *n* containers selected shall bear the seals of both the purchaser and the supplier. They shall be kept at a place agreed to between the purchaser and the supplier and shall be used in case of any dispute between the two.

A-4. NUMBER OF TESTS

A-4.1 Tests for requirements as given in **5.2.1**, **5.2.1** (a) and **5.2.1** (b) shall be performed on each of the individual samples taken for this purpose.

A-5. CRITERIA FOR CONFORMITY

A-5.1 A lot shall be accepted as conforming to this specification if the samples tested meet all the requirements given in **5.2.1**, **5.2.1** (a) and **5.2.1** (b).

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